Republic of the Philippines

Ex-Post Evaluation of Japanese Grant Aid Project
"The Project for Improvement of Flood Forecasting and Warning System in the Pampanga and Agno River Basins"

External Evaluator: Kenichi Inazawa, Octavia Japan Co., Ltd.

0. Summary

With an aim to improve the function of flood forecasting and warning system (hereinafter referred to as "FFWS"), this project enhanced FFWS related facilities and procured and installed materials and equipment in Pampanga and Agno River Basins located in the Central Luzon Region. At the time of the ex-post evaluation, this project is in line with the policy such as "the Mid-Term Philippine Development Plan" and the development needs to further improve FFWS; thus relevance is high. Through this project, the missing rate of data collection in the telemetry system and the observation time for FFWS improved mostly as planned. In addition, interviews with the local government agencies and towns/villages (barangays) confirmed that FFWS developed by the project was transmitting accurate rainfall and water-level information to the relevant agencies and securing sufficient time for evacuation (lead time) at times of floods. Thus effectiveness and impact is high. Although the project cost was within the plan, the project period exceeded the plan; thus efficiency is fair. On the other hand, problems were not observed in the institutional, technical and financial aspects of PAGASA, the implementing agency; thus sustainability is high.

In light of the above, this project is evaluated to be highly satisfactory.

1. Project Description

Project Location

Rehabilitated Agno Sub Center

1.1 Background

In Pampanga and Agno River Basins located in the Central Luzon Region, infrastructure

development such as highway constructions is advanced, and the population is growing rapidly in recent years. The FFWS[1] of the two river basins was more than 20-30 years old; facilities such as rainfall and water-level gauging stations across the river basins were deteriorating. In addition, the two river basins were devastated by a number of natural disasters, including volcanic mudflow caused by the eruption of Mount Pinatubo, earthquakes in and around Baguio of the Cordillera Administrative Region and frequent typhoon occurrences (3-5 times a year on average) in the 1990s. For example, a large amount of collapsed sediment and volcanic sediment flew into the river, and sediment accumulated in the river channels. As a result, riverbeds rose and caused bank collapses in midstream and expansion of flood areas and prolongation of inundation period in downstream. Additionally, after the rise in riverbeds in the 1990s, the flood risk was increasing in the area. Out of the fifteen water-level gauging stations that existed, there were difficulties in measuring accurate water levels at eleven stations. Therefore, there was an urgent need to rehabilitate/improve/enhance the FFWS in both of the river basins with a view to providing accurate flood information to the residents.

1.2 Project Outline

The objective of this project is to improve the function of FFWS by replacing non-operational FFWS facilities/putting-up additional monitoring stations/improvement of backbone for telecommunication, thereby contributing to the prompt and precise information dissemination to the residents in the river basins and to the realization of safe evacuation in Pampanga and Agno River Basins in the Central Luzon Region.

Grant Limit / Actual Grant Amount	1,155 million yen (The 1st phase: 779 million yen, the 2nd phase: 376 million yen) / 1,055 million yen (The 1st phase: 730 million yen, the 2nd phase: 325 million yen)
Exchange of Notes Date (/Grant Agreement Date)	The 1st phase: July 2007 The 2nd phase: October 2008
Implementing Agency	Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)

[1] How flood forecasting and warning works is that, PAGASA, the implementing agency of this project, predicts what scale of flood is likely to occur in different area based on predicted rainfall, observed rainfall, observed water level and predicted typhoon routes and issues flood bulletins to the local government agencies within the concerned river basins.

Project Completion Date	February 2011 (The 1st phase: March 2009, the 2nd phase: February 2011)
Main Contractor	Toyota Tsusho Corporation
Main Consultant	Nippon Koei Co., Ltd.
Basic Design	October 2006 – March 2007
Detailed Design	N/A
Related Projects	【Technical Cooperation Projects】 ・"Flood Forecasting and Warning Service Strengthening Guidance Project" (2004-2006) ・"The Project for Strengthening of FFWS for Dam Operation" (2009-2012) ・Experts Dispatched (8 persons in total, 2004-2006) ・Counterpart Training (5 persons in total, 2005) 【Grant Aid Projects】 ・"The Project for Establishing Pampanga River Basin FFWS" (1973) ・"The Project for Improvement of FFWS in the Pampanga River Basins" (1981) 【ODA Loan (JICA Loan)】 ・"FFWS for Dam Operation Project" (The loan agreement was signed in 1982) ・"Agno and Allied Rivers Urgent Rehabilitation Project" (The loan agreement was signed in 1995) ・"Agno River Flood Control Project (II) and (II-B)" (The loan agreement was signed in 1998 and 2001 accordingly)

2. Outline of the Evaluation Study

2.1 External Evaluator

Kenichi Inazawa, Octavia Japan Co., Ltd.

2.2 Duration of Evaluation Study

Duration of the Study: November 2013–September 2014

Duration of the Field Study: January 19–February 1, 2014, April 20–26, 2014

3. Results of the Evaluation (Overall Rating: A[2])

3.1 Relevance (Rating: ③[3])

3.1.1 Relevance to the Development Plan of the Philippines

Before the project commencement, the Philippine government formulated the "Mid-Term Philippine Development Plan" (2004-2010). In this plan, disaster reduction was identified as an important issue, along with the strengthening of disaster prevention organizations and FFWS. Additionally, in the "National Science and Technology Plan", which was formulated with the aim of improving the science technology capability with a target year of 2020, improvement of disaster prevention function with the utilization of scientific technologies was identified as an important task.

At the time of the ex-post evaluation, the government formulated the "Philippine Development Plan" (2011-2016). This plan recognizes that climate change and its effects on natural disasters will lead to more poverty and environmental degradation. Based on such understandings, the government enacted the "Disaster Risk Reduction and Management Council Act" (Republic Act No. 10121) in 2010, emphasizing "the importance of establishing a framework for the national disaster risk reduction efforts" by using integrated methods to manage natural and human disasters. This act recognizes that Early Warning System (EWS) plays an important role in enhancing local communities' resilience against disasters and in strengthening their abilities to respond to disasters.

In light of the above, it can be considered that disaster prevention and response in the Philippines are consistent with the policy such as the national and sector plans, before the project commencement as well as at the time of the ex-post evaluation.

3.1.2 Relevance to the Development Needs of the Philippines

Japan has been providing assistance concerning FFWS to the Philippines since the 1970s. With regard to Pampanga and Agno River Basins, Japan has developed FFWS, piloted projects and rehabilitated existing equipment through ODA loans and grant aid projects thus far. At the time of the ex-ante evaluation, FFWS of the two river basins was already operating for more than 20-30 years old. The facilities were deteriorating severely, which contributes to the

[2] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[3] ③: High, ②: Fair, ①: Low

difficulties in accurately measuring water levels at eleven water-level gauging stations out of the fifteen that existed. In addition, the existing backbone multiplex radio network, which connects the gauging stations and regional monitoring offices (hereinafter referred to as "sub centers") to the central monitoring center located in Manila, was unstable due to frequent network interruption by mobile phone interference. Thus real-time monitoring or prompt and accurate transmission of flood related data was intermittent at the central monitoring center (though at the Sub-Center, data were being transmitted). As a result, there was difficulty in providing timely and appropriate information to the local residents, and there was a concern that evacuation activities would be prolonged, inflicting further damage. Therefore, it was highly necessary to improve the FFWS in both areas.

At the time of the ex-post evaluation, the Philippine Atmospheric, Geophysical and Astronomical Services Administration (hereinafter referred to as "PAGASA"), which is the implementing agency of this project, is considering the introduction of FFWS to other major river basins[4] in the Philippines. This reflects PAGASA's direction toward disaster risk reduction. Given the situations of the Philippines concerning flood forecast and warning, JICA is also conducting a basic information gathering survey[5] on flood forecasting and warning covering the entire Philippines, with the objective of identifying needs for future assistance, including a possibility of applying Japan's state-of-the-art technologies related to flood forecasting and warning.

In light of the above, need for FFWS development continues to be placed an importance. Therefore, the project is considered to be consistent with the development needs before the project commencement as well as at the time of the ex-post evaluation.

3.1.3 Relevance to Japan's ODA Policy

The Country Assistance Plan for the Philippines, which was developed by the Ministry of Foreign Affairs of Japan in 2000, identified the following priority areas and sector assistance policy: (1) "strengthening the economy and overcoming growth constraints toward sustained economic growth"; (2) "rectification of disparities (alleviating poverty and redressing regional disparities)"; (3) "environmental protection and anti-disaster measures"; and (4) "human resources development and institution building". With regard to (3), it is stipulated that "because

[4] The other thirteen major river basins are Abra and Abulug (Luzon), Panay, Jalaur and Ilog-Hilabangan (Visayas), Agusan, Agus-Lanao Lake, Buayan-Malungon, Cagayan de Oro, Mindanao/Cotabato, Davao, Tagoloan and Tagum-Libuganon (Mindanao). The river basins in which FFWS has already been established are Agno, Bicol, Cagayan, Marikina and Pampanga (5 in all), all located in the Luzon Region.

[5] It was completed in September 2013.

frequent large-scale natural disasters constrain development, and also tend to impact more heavily on the poor, we will continue to provide aid for flood and sand control and earthquake-related measures, while also assisting in developing the necessary systems and capacity in related government institutions from a medium- to long-term perspective." This project aimed to strengthen the disaster prevention function of the Philippines and is in line with the above priority and sector assistance policy (environmental protection and anti-disaster measure). Therefore, it is consistent with the assistance policy of Japan.

This project has been highly relevant to the Philippine's development plan, development needs, as well as Japan's ODA policy. Therefore its relevance is high.

3.2 Effectiveness[6] (Rating: ③)

3.2.1 Quantitative Effects (Operation and Effect Indicators)

Through this project, it was aimed that the missing rate of data collection in the telemetry system would improve from 50% to 3.6% and the observation time would reduce to about 10 minutes for the FFWS in Pampanga and Agno River Basins by procuring and installing new telemetering equipment for rainfall and water-level gauging stations and data processing. Table 1 shows the target and actual data before the project commencement and after the project completion.

Table 1: Changes in the Missing Rate of Telemetry Data Collection and the Observation Time

Output Indicator	Before Project Commencement		After Project Completion			
	Actual (2007)	Target After Project Completion (2010)	2010	2011	2012	2013
1) Missing rate of data collection in the telemetry system	50%	3.6%	Approx. 3.0%	Approx. 2.7%	Approx. 0.3%	Approx. 1.2%
2) Observation Time[7]	About 2 hrs	About 10 min	About 5-10 min			

Source: JICA document (at the time of the ex-ante evaluation), answers to the questionnaire (at the time of the ex-post evaluation)

1) Missing Rate of Data Collection in the Telemetry System

As shown in Table 1, the missing rate of data collection in the telemetry system was expected

[6] Sub-rating for Effectiveness is to be put with consideration of Impact.

[7] It refers to the minimum time required for the telemetry observation system to collect data automatically.

to become 3.6% after the completion of this project. According to JICA document, this target was set with the understanding that "it might become impossible to collect data at one station due to flood damage (i.e., 3.6%), although the missing rate could become almost 0% in theory after the improvement (of the FFWS with the procurement of equipment and devices by this project)." In 2010 some data was missing[8] because the sensor signal cable, which had been installed at Mayapyap rainfall gauging station, was stolen. In 2011, the recovery work which began in 2010 was still on-going at Mayapyap rainfall gauging station, while sensor signal cables were also stolen at Peñaranda and Arayat rainfall gauging stations, resulting in missing data[9]. In 2012 the recovery work for Arayat rainfall gauging station still continued, resulting in missing data[10]. In July 2013, a sensor signal cable of Mayapyap rainfall gauging station was vandalized and immediate repair was undertaken. During the occurrence of typhoon in October 2013, the antenna tower of Mayapyap station was damaged, resulting in missing data[11]. Based on the above, the missing rates were within the initial target although some data was missing each year; thus it can be said that FFWS telemetry observation system is generally functioning well. With regard to the ways in which the Philippine side is addressing the theft of sensor signal cables, it will be discussed in the "Status of Operation and Maintenance" below.

2) Observation Time

Before the project commencement, data collection normally took about 2 hours. This is mainly because data had to be measured visually due to the failure of the telemetry observation system. Through this project, the accuracy of rainfall and water-level measurement was expected to improve, and the observation time was expected to reduce greatly (from about two

[8] It was stolen in March 2010, and the recovery work was completed in March 2011. In other words, in the year of 2010, data could not be collected from March to December for roughly 10 months at this station. Thus the missing rate is calculated to be approximately 3.0% (=3.6% x 10months / 12 months).

[9] In 2011 (1) the missing rate was approximately 0.9% (= 3.6% x 3 months / 12 months) at Mayapyap rainfall gauging station due to the recovery work which was carried out from March 2010 to March 2011 following the theft; (2) the missing rate was approximately 0.3% (3.6% x 1 month / 12 months) at Penaranda gauging station due to the theft in May as a result of which recovery work continued until the end of June, leading to about one month of missing data from May to June; and (3) there were incidences of theft at Arayat gauging station in August and December. The recovery work for the theft in August was completed in November, while the recovery work for the theft in December was completed at the end of January 2012, making the data missing period five months (from August to December); thus the missing rate can be calculated to be approximately 1.5% (= 3.6% x 5 months / 12 months). Based on the above, the total missing rate of data collection adds up to approximately 2.7% (0.9 + 0.3 + 1.5%).

[10] Because the sensor signal cable was stolen at Arayat gauging station in December 2011, the recovery work continued until the end of January 2012. As there is about one month of data missing period in the year of 2012, the missing rate is calculated to be approximately 0.3% (= 3.6% x 1 month / 12 months) for 2012.

[11] The recovery work is not progressing at the time of the ex-post evaluation (January 2014). However, PAGASA is procuring heavy machinery and following up on the approval of the fund for the recovery work. The data missing period is roughly four months (from September to December), and the missing rate of data collection is calculated to be approximately 1.2% (= 3.6% x 4 months /12 months).

hours to 10 minutes). Through the interviews with PAGASA staff members conducted as part of this evaluation study, it has been confirmed that the observation time is now roughly 5-10 minutes mainly because the telemetry observation systems were renewed by this project. Therefore, it can be said that the target has also been achieved in terms of observation time.

Photo 1: Constructed Pampanga Sub Center

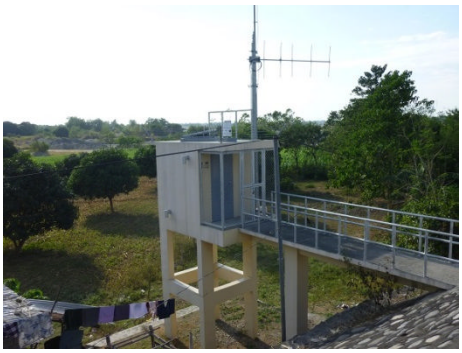
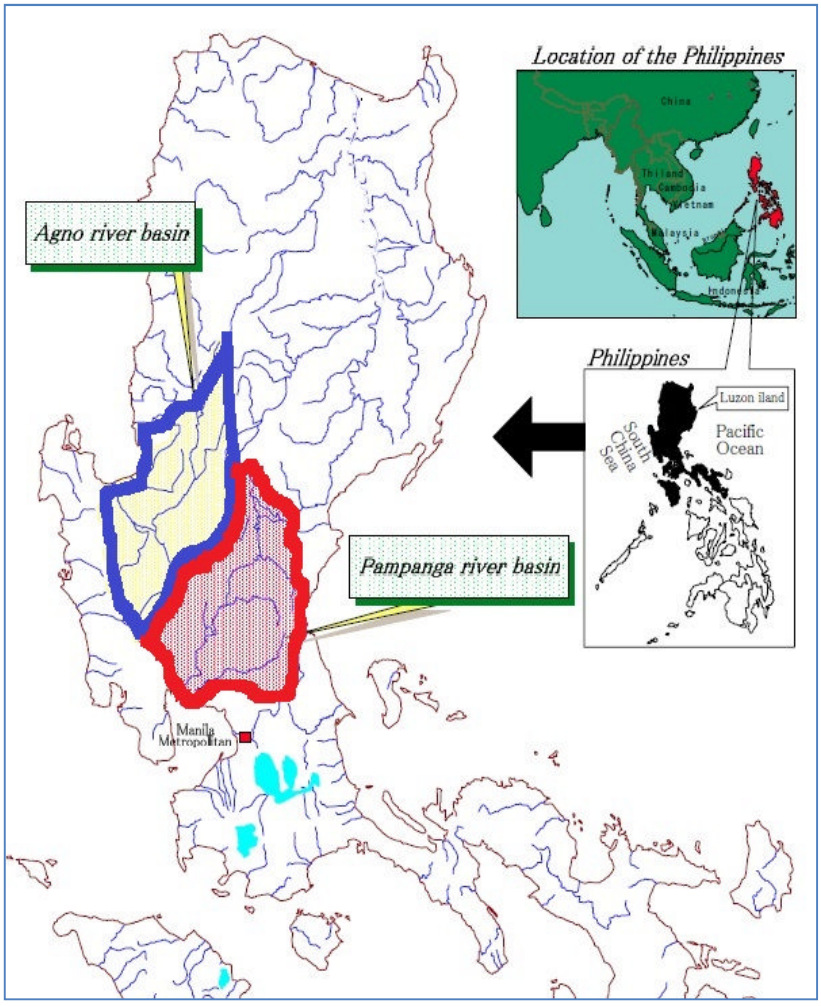


Photo 2: Developed Rainfall Gauging Station (Santa Maria, Agno River Basin)



Source: JICA document

Figure 1: Locations of Project Sites

3.2.2 Qualitative Effects

1) Stabilized Telemetry System Operation

At the time of the ex-post evaluation, the telemetry observation facilities newly procured and installed by this project are functioning well without failure or problem. Through the interviews with the staff of Pampanga and Agno Sub Centers and PAGASA headquarters and through site visits, it has been confirmed that neither malfunctioning nor deterioration of data accuracy was observed. According to the staff interview, the following comment was received: “We can prevent troubles related to the procured and installed facilities by carrying out our day-to-day work carefully. By doing so, we can also improve durability of the facilities.” Considering such a comment, it can be judged that with continuous and proper maintenance the operation has stabilized as compared to before the project commencement.

2) Improved Operational Technology and Management of PAGASA Staff

As part of the soft-component training (technical assistance), training was held for Telecom Engineers/Technicians and Hydrologists in operation and maintenance of FFWS, outflow forecasting technologies and over flood analysis technologies. According to the interviews with training participants, they commented, “The content of the training was useful. In some occasions we utilize what we learned during the training, and it is giving us more confidence in what we do.” It can be judged that participants learned sufficient knowledge and technologies concerning operation and maintenance of software for outflow forecasting and over flow analysis through the training. In addition, PAGASA has a plan to organize internal training for other staff members. Therefore, it can be judged that knowledge of the staff will continue to improve and be accumulated.

3.3 Impact

3.3.1 Intended Impacts

3.3.1.1 Contribution to the Prompt and Accurate Dissemination of Flood Forecasting and Warning Information to the Residents and the Realization of Safe Evacuation

1) Prompt and Accurate Dissemination of Flood Forecasting and Warning Information to the Residents

PAGASA’s information transmission of FFWS begins by predicting rainfall, water levels, typhoon routes and flood scales. Based on such prediction, PAGASA prepares a flood bulletin and alerts institutions that are managing dams in the river basins (the National Irrigation Administration or the National Power Corporation), local government agencies (Local

Government Units and Provincial Disaster Risk Reduction and Management Offices), the Office of Civil Defense (OCD)[12], the media and so on. Then, residents in the affected river basin can obtain flood forecasting and warning information through the public wireless broadcasting (disaster prevention public wireless broadcast) by the Local Government Units and Provincial Disaster Risk Reduction and Management Offices, from the media such as radio and from internet. The number of people who can receive flood forecasting and warning information (i.e., beneficiaries of this project) is estimated to be approximately 7-8 million[13] in Pampanga River Basin and 3-4 million[14] in Agno River Basin (calculated based on the population data of 2010).

As a result of the interviews with local government agencies in Pampanga and Agno River Basins concerning the FFWS developed by this project, the following comments were received from various sectors. It can be observed that precise information such as rainfall and river water level is being disseminated to the concerned agencies in an accurate and prompt manner and such information is being utilized effectively.

Box 1. Results of Interviews with Relevant Local Government Agencies

■ The National Irrigation Administration (NIA), which operates Pantabangan Dam located upstream in Pampanga river, commented in interview, "Before the project commencement, we used to rely on radio broadcasting for flood forecasting and warning. At that time mobile phones were not as widespread as they are now; and it was not easy to promptly obtain accurate information. As a result of the development of FFWS through this project, information on rainfall and river water level is instantly provided to the residents, farmers, Local Government Units and the Office of Civil Defense. In other words, people are now able to obtain information at all times and know when to evacuate. They can utilize data any time. We consider this to be a big change."

■ The Provincial Disaster Risk Reduction and Management Office (PDRRMO) of Bulacan and Pampanga Provinces commented in interview, "Although we do not have too many actual cases as there has not been heavy rain or flood of large scale in the past few years, we trust

[12] It is a governmental organization mandated to reduce and manage disaster risks. In the Philippine the "Disaster Risk Reduction and Management Act (DRRM Act)" (Republic Act No. 10121) was enacted in May 2010. With a view to managing disaster risks in a more comprehensive manner by incorporating prevention and reduction to the conventional post disaster responses, the act stipulated a fundamental framework for disaster prevention based on a new approach called disaster risk reduction and management. The National Disaster Risk Reduction and Management Council (NDRRMC) has been established by the DRRM Act as the highest decision making body related to national-level disaster management. The OCD serves as the administrative body of the NDRRMC.

[13] It was estimated based on the combined population of Nueva Ecija Province, Pampanga Province, Bulacan Province and a part of Tarlac Province.

[14] It was estimated based on a part of Benguet Provice, Pangasinan Province and a part of Tarlac Province.

river water-level and rainfall data managed by PAGASA. Flood-related information sent from PAGASA is useful in informing the residents about evacuation routes and places. That is to say, it enables us to smoothly conduct evacuation management in times of flood."

■ As a result of the interview with a barangay managing a community tends to experience relatively severe flood in Pampanga River Basin, they commented, "We think that nowadays there is sufficient lead time in case of evacuation caused by flood. Residents normally need substantial time to take valuables from their houses; and the current lead time is sufficient. Before (the implementation of this project), it took time to acquire information on rainfall and river water-levels. The communication and collaboration among the concerned institutions were not necessarily satisfactory, either. At present, however, the reliability has improved partly because of the development and improvement of the equipment system. Additionally, it is also valuable that one can access rainfall and water-level information provided by PAGASA using internet such as Social Networking Service (SNS)[15].

To take Pampanga River Basin as an example, after the project completion, a total of 18 flood bulletins were issued for Typhoon Pedring and Typhoon Quiel in 2011. In August 2012 when the area was hit by heavy rain, a total of 22 flood bulletins were issues. It can be observed that, after this project the arrival time of flood is more accurately cited in the bulletin today as compared to before the project commencement. This presumably explains the above positive comments from various sectors[16].

2) Contribution of Hazard Map Development to the Realization of Safe Evacuation

The Local Government Units of Pampanga and Bulacan Provinces visited during this evaluation study have been preparing hazard maps[17]; thus the FFWS developed by this project is contributing to the preparation of more precise hazard maps. According to the interviews with the Provincial Disaster Risk Reduction and Management Office of both provinces, they commented, "For example, by informing each Local Government Unit about rainfall and river water-levels accurately and promptly, we are able to provide more concrete information than

[15] The interviewed barangays have dedicated staff to monitor rainfall and water-level data provided by Pampanga Sub Center located upstream. By utilizing such data, they provide information like evacuation time to the local residents.

[16] In addition, it was observed through the interviews that PAGASA and relevant agencies have improved their cooperation.

[17] In fact, after the establishment of the "Philippine National Disaster Risk Reduction and Management Council Act" (Republic Act No. 10121) described in "Relevance to the Development Plan of the Philippines" under Relevance, local government units are making efforts to develop hazard maps as per this law.

before, such as areas in which area flood is likely to occur, when the water level is likely to be high and different routes to evacuation places." In addition, the above-mentioned barangay that was visited during the evaluation study, is organizing advocacy seminars concerning flood hazard maps for local residents a few times a year[18]. They are working toward safer evacuation by giving lectures on how to utilize flood hazard maps, guidance on evacuation routes and how to respond to floods. Considering such cases, coupled with the development of FFWS by this project, it can be presumed that efforts are being made toward safe and prompt evacuation with the utilization of flood hazard maps in both provinces at the community level in the both river basins.

Photo 3: PAGASA Headquarters (Hydrometeorological Division)

Photo 4: Flood Caused by Heavy Rain in August 2012 (Pampanga Province)

3.3.2 Other Impacts

3.3.2.1 Impacts on the Natural Environment

The environmental and social aspects that had been considered concerning this project were water-level gauging stations to be established along the rivers and rainfall stations to be established within the premises of schools and government agencies, etc. It was considered that these facilities would not have any negative impact on the environment and society, such as impacts on nature and resettlement. Thus the implementation of the Environmental Impact Assessment (EIA) was not required. PAGASA obtained a certificate of non-coverage that the EIA was not necessary for the facilities to be constructed from the Department of Environment and Natural Resources (hereinafter referred to as "DENR") before the project commencement.

It has been confirmed through the interviews with staff of PAGASA headquarters as well as Pampanga and Agno Sub Centers that no environmental problem (noise, air pollution, dust

[18] According to PAGASA, although the exact number or the contents of activities are unknown, barangays other than the one that was visited are also conducting similar advocacy seminars and that they tend to be located in areas likely to be more affected by flood within Pampanga and Agno River Basins.

generated by passing vehicles, etc.) was observed within the project sites during the project implementation as well as after the project completion.

There has not been any particular need for environmental monitoring on the facilities and equipment developed by this project after the project completion. Neither PAGASA nor its supervising ministry, the Department of Science and Technology (DOST), has an established structure for environmental monitoring. According to PAGASA, in case any negative environmental problem occurs, DENR will first look into the fact and try to address the issue[19].

3.3.2.2 Land Acquisition and Resettlement

Resettlement was not required in this project. On the other hand, some land became subject to acquisition for the construction of Pampanga Sub Center and rainfall gauging station. Since much of the land was originally owned by the government (state-owned land), PAGASA was able to proceed with the acquisition smoothly by discussing with local government unit. With regard to the land for the telecommunication steel tower, it was also owned by the government (the National Irrigation Administration (NIA), the National Power Corporation (NPC) and the National Grid Corporation of the Philippines (NGCP)). Thus the procedure went smoothly without any particular problem.

This project has largely achieved its objectives. Therefore its effectiveness and impact is high.

3.4 Efficiency (Rating: ②)

3.4.1 Project Outputs

Table 2 shows the planned and actual outputs of this project.

Table 2: Planned and Actual Outputs of this Project[20]

Plan (Before Project Commencement)	Actual (At the Time of Ex-Post Evaluation)
【Planned Inputs from the Japanese Side】	【Actual Inputs from the Japanese Side】

[19] However, the reason why they do not have any established monitoring structure is probably because they have not had any actual cases and problems have not occurred until the time of the ex-post evaluation.

[20] The names of the project components borne by the Japanese side differ between the plan (left-hand column) and the actual (right-hand column) because the project was implemented in two phases and the completion reports submitted by the main consultant had different names.

1) Civil work (new gauging stations) - Renewal and addition of telemetry observation systems: 28 stations in total 2) Civil work (other construction work at the gauging stations) - Embankment works: 2 sites - Office construction: 15 gauging stations - Water level gauge support works: 12 gauging stations 3) Installation and adjustment of equipment (all stations) -Renewal of telemetry observation systems: 1 new gauging station and 2 renewed gauging stations - Renewal and establishment of multiplex-radio system: 7 links of 7.5GHz band, 2 links of 18GHz band (out of which 1 link of 18GHZ band is to be newly established) - Renewal and new establishment of facilities at relevant agencies (equipment for the agencies working in disaster prevention by collaborating with PAGASA, such as the Department of Public Works and Highways, the National Power Corporation and National Irrigation Administration and their respective dam sites and Office of Civil Defense): 5 renewals and 2 new sites 4) Steel tower construction (all constructions including new and reinforcement) - 4 new constructions and 4 reinforcement sites 5) Equipment removal - one set * Transfer of technology to enable smooth operation and maintenance of the above (soft	(Phase I) 1) Telemetry subsystem[21] (a) Rainfall gauging station: 4 new constructions and 3 renewals (b) Rainfall and water-level gauging stations: 2 new constructions and 8 renewals 2) Data processing subsystem[22] (a) New construction of monitoring center: 1 site (b) Renewal of central monitoring center: 1 site (c) Renewal of disaster prevention agencies: 4 sites (d) Renewal of dam sites : 3 places 3) Backbone multiplex radio network subsystem[23] (7.5GHz: 5 sections, 18GHz: 2 sections) 4) Communication antenna tower (3 new construction and 3 renewals) 5) Civil works (embankment works at 2 places, construction of 9 station buildings and supporting works for water level sensors at 7 places) (Phase II) 1) Telemetry subsystem (a) Rainfall gauging station: 3 new constructions (b) Rainfall and water-level gauging stations: 3 new constructions and 5 renewals 2) Data processing subsystem (a) New construction of monitoring center: 1 site (b) Renewal of central monitoring center: 1 site 3) Backbone multiplex radio network subsystem (7.5GHz: 2 sections) 4) Communication antenna tower (1 new construction) 6) Civil works (embankment works at 2 places, construction of 7 station buildings and supporting works for water level sensors at 6 places) * The soft component listed on the left-hand column was implemented as planned.

[21] It measures rainfall and water-level data at the station and transmits it to the repeater station through 150 MHz band radio channels.

[22] It collects and saves the observation data, monitors at monitoring centers (data information centers and sub centers) and provides information to the relevant agencies and dam sites.

[23] It is a radio system used to transmit observation and voice data (Voice over IP) using 7.5GHz and 18GHz bands.

component) ・Technical support for the operation and maintenance ・Technical support for the outflow forecasting and overflow analysis 【Planned Inputs from the Philippine Side】 1) Construction of Pampanga Sub Center building 2) Rehabilitation of the Agno Sub Center, including the construction of additional floor/level of the building 3) Permission to use frequencies and communication equipment 4) Strengthening of operation and maintenance capability 5) Restoration or repair of existing facilities 6) Removal or reuse of existing facilities and equipment 7) Coordination and securing permission from LGUs, government, including schools, and private entities where stations and communication towers will be established, including the schedule of project implementation to ensure that there will be no interruptions of their activities 8) Securing VAT budget 9) Licensing and securing approval/ permission for cutting trees near the site, land acquisition, Height Clearance Permit, required permits from the concerned Local Government Units prior to the start of construction, etc.) 10) Other procedures (provision of temporal storage space for equipment and processing of the permission for antenna tower construction) 11) Construction of new Repeater Equipment/DEG Room at Cuyapo Repeater site	【Actual Inputs from the Philippine Side】 The outputs on the left-hand column were delivered almost as planned.

Source[24]: JICA document (The names of the planned items were mostly taken from the Basic Design Study Report of the project, while names of the actual items were taken from the completion reports.)

The outputs from the Japanese and Philippine sides were implemented almost as initially

[24] The information on outputs "before the project commencement" was taken from the Basic Design Study Report, while the information on outputs "after the project completion" was taken from the project completion reports. This is why the terms and the list differ between the left- and right-hand columns. (It was difficult to list them in a strictly consistent manner because the former lists information concerning the entire plan, while the latter lists information based on the construction phase (Phase I and Phase II).)

planned. On the other hand, there are some disparities as described below. The main reason is that some changes were made at the time of the detailed design.

① Construction of Station Buildings (15 stations were planned but 16 were actually constructed) and Construction of Steel Tower (4 places were planned to be renewed but 3 were actually renewed)

Initially, it was planned to establish 7.5 GHz multiplex-radio system connecting "Rosales (Agno Sub Center) – Tarlac (Ultra High Frequency (hereafter referred to as "UHF") repeater station) – Cabanatuan (existing UHF radio repeater station)" with the aim of utilizing FFWS facilities at Agno Sub Center. This plan included the construction of telecommunication steel towers: the existing 28m tower was to be changed to a new 35m tower in Rosales; the existing tower was to be changed to a new tower in Tarlac; and a new 35m steel tower was to be constructed in Cabanatuan. However, at the time of the detailed design it was found that a small airport[25] existed near Rosales, and the project could not obtain permission for the construction of a steel tower in Rosales from the aviation authority. The new repeater station was thus decided to be constructed in Cuyapo, a short distance away from Rosales. The multiplex-radio system was thus actually established connecting "Rosales – Cuyapo (new repeater station) – Cabanatuan." As a result of this change in the detail design, it became unnecessary to construct towers in Rosales and Tarlac (2 stands), while the need arose to construct a new station building and a steel tower (20m, 1 stand) in Cuyapo[26].

② Water Level Gauge Support Works (12 places were planned but 13 were actually constructed)

The initial plan was to put one water-level gauge at Agno Sub Center. During the project implementation, however, it was found that the water level could reach up to the second floor of the center in case of flood. Hence, 2nd floor of the building was added/constructed to ensure that new equipment that will be provided by the Project will be protected in the event that high flood waters will inundate the area.

③ Construction of Data Processing Sub System (1 new establishment was planned, but 2 new systems were established in reality)

Before the project commencement, Pampanga Sub Center was located inside PAGASA' headquarters (Quezon City) in Manila. However, with a view to making their work closer and more relevant to the community, it was decided at the time of the detailed design that the sub center should be constructed in Pampanga Province. Following this decision, it was also decided to establish a data processing sub system inside the new sub center. (In other words, Pampanga Sub Center became a subject for data processing sub system in addition to Agno Sub Center.)

[25] However, the airport has not been in use since then up to today.
[26] According to the interview with the main consultant, the construction cost was cheaper for the station building and steel tower in Cuyapo than for the steel towers in Rosales and Tarlac.

Photo 5: Data Processing System inside Agno Sub Center

Photo 6: Constructed Telecommunication Steel Tower

3.4.2 Project Inputs

3.4.2.1 Project Cost

The total project cost was initially planned to be 1,216 million yen (out of which 1,155 million yen was to be borne by the Japanese side, while roughly 61 million yen was to be borne by the Philippine side). The actual project cost was roughly 1,129 million yen (out of which 1,055 million yen was borne by the Japanese side, while roughly 74 million yen was borne by the Philippine side), which was lower than planned (93% of the plan). The project cost borne by the Japanese side was roughly 100 million yen less than what was planned because the project managed to reduce cost by applying competitive bidding, a cost efficient method. On the other hand, the project cost borne by the Philippine side was higher than planned. It is mainly because there was disparity between the actual VAT amount and the estimated amount[27].

3.4.2.2 Project Period

The project period was planned to be 2 years and 8 months (32 months) from July 2007 to February 2010. In reality it took 3 years and 8 months (46 months) from July 2007 to April 2011, with a delay of about 14 months. The main reasons for the delay are as the following: (1) the project was not successful in selecting a bidding winner for equipment procurement the first time, and it had to be re-announced and required long time to identify a supplier; and (2) as described above, a change was made at the time of the detailed design in relation to the construction of station building and steel towers. As a result, the cost had to be recalculated, and

[27] In principle, VAT applies to construction works and purchasing of materials and equipment in the Philippines. The amount of VAT required for this project was underestimated because before the project commencement the austerity measures were in place by the administration at that time (the Arroyo administration). As the actual VAT expended was more than the initial estimate, it created the disparity.

it required time to discuss the recalculated cost with PAGASA and also to follow through the procedures necessary for making changes to the project.

Although the project cost was within the plan, the project period exceeded the plan. Therefore efficiency of the project is fair.

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

The main activities of PAGASA include meteorological observation, communication and analysis as well as other related research and advocacy. The supervising ministry of PAGASA is the Department of Science and Technology (DOST), and it has a total of 881 staff members (as of September 2013). In fact, the number of staff has reduced from 1,122 which was before the project commencement (2005). It is because of the rationalization plan which was implemented in 2008-09, which encouraged early retirement, froze new recruitment and reshuffled existing staff within the organization. According to the interviews with the management of PAGASA, they commented, "Although the number of staff members has reduced, we are optimizing our work by placing the right people in the right places. We also have sufficient number of staff assigned for the operation and maintenance works."

It is the Hydrometeorological division (hereinafter referred to as "HMD") that is responsible for flood forecasting and warning within PAGASA. HMD collects and analyzes flood-related data such as rainfall and water levels, manages database, forecasts floods, transmits flood information and maintains telemetry equipment. HMD has a total of 49 staff members (as of September 2013). On the other hand, it is the sub centers (4 centers in total[28]) that are observing floods and operating gauging stations in the regions. Each sub center closely works with HMD and provides flood-related information to the local governmental agencies and media. Table 3 shows the numbers of PAGASA staff and personnel responsible for the operation and maintenance of this project. The hydrologists and hydro aides shown in the table refer to staff members who are responsible for flood forecasting and warning. Similarly, telecom engineers and technicians refer to staff members who maintain rainfall and water-level gauging stations as well as telecommunication steel towers. Telecommunication personnel who belong to HMD go around and visit each sub center to collaborate with the sub-center telecommunication personnel for the maintenance work. According to the management of HMD, Pampanga and Agno Sub

[28] There are Bicol and Cagayan Sub Centers in addition to Pampanga and Agno Sub Centers.

Centers who were interviewed, they “have just enough people to carry out the required tasks.”

Table 3: Staffing Levels at HMD and Each Sub Center

Name	Hydrologists and Hydro Aides	Telecom engineers and technicians
HMD	20 persons	13 persons
Pampanga Sub Center	4 persons	1 person
Agno Sub Center	5 persons	2 persons

Source: Answers to the questionnaire

With regard to the system of maintenance for the FFWS facilities and equipment procured and installed by this project, HMD’s telecom engineers and technicians are conducting maintenance and inspection every three months. In case telecommunication equipment requires major repairs and if the situation is beyond the capacity of PAGASA, they contact the local office of the supplier (Japanese-affiliated company) to address the matter.

Based on above, it can be judged that HMD and sub centers have sufficient numbers of staff. It is also observed that a system in place to maintain the facilities and equipment. Therefore, no major problems are observed in the institutional aspects of the operation and maintenance system.

3.5.2 Technical Aspects of Operation and Maintenance

Since the completion of this project, PAGASA has been conducting training periodically for hydrologists and hydro aides, telecom engineers and technicians and Pampanga and Agno Sub Center staff[29]. Additionally, it has been confirmed through the interviews that that PAGASA’s staff members were fully aware of the importance of operation and maintenance as well as the functions and specifications of the facilities and equipment procured by this project. Furthermore, it has also been confirmed through the interviews that the telecom engineers and technicians responsible for the operation and maintenance of the facilities and equipment had extensive professional experience and were skilled to address the failure or problem of telemetry observation systems.

For newly recruited staff, training is also provided. On the other hand, the need was observed to increase the number of young staff in order to revive the organization in the future. Although

[29] For example, they conducted practical training, including “Training on Operation and Maintenance of the Flood Forecasting and Warning Facilities and Equipment in Agno and Pampanga River Basins” (2011), “Quantitative Rainfall Forecasting Training” (2012), “Seminar on Data Collection for Country-Wide Flood Forecasting and Warning” (2013).

training is provided to young staff, there seems to be a need to increase the number of staff and the number of training, thereby revitalizing the organization.

In addition to the above-mentioned internal training for its staff, PAGASA is also organizing the Hydrologist Training Course (HTC) on the subject of hydraulic and hydrological technologies. It is because PAGASA hopes to secure human resources from the training participants when they commence new projects in the future, particularly the expansion of the flood forecasting and warning services in other major river basins in the Philippines. A total of 32 individuals have attended this training series since it began in August 2013. PAGASA is able to conduct training in such a way that it responds to the demands of the public because they have been developing human resources backed by long years of Japan's technical assistance. It is also because PAGASA has been steadily organizing internal training since the late 1990s and has been making efforts to send its staff to different training courses in and outside the Philippines.

Based on the above, PAGASA has been holding training frequently and its staff members have ample professional experience. It can thus be considered that the technical standard of PAGASA is sufficient to handle the periodic operation and maintenance. Therefore, no major problems are observed in the technical aspects of the operation and maintenance system.

3.5.3 Financial Aspects of Operation and Maintenance

Table 4 shows the changes in the personnel and maintenance cost for PAGASA as a whole. The cost is increasing after the project completion as compared to that of the three years before the project commencement. It is because PAGASA's workload has been increasing across the organization in relation to meteorological observation, telecommunication, analysis, forecasting and warning as well as related research and advocacy work. Accordingly, the needed budget has been allocated by the central government.

Table 4: Personnel and Maintenance Cost for PASASA as a Whole

(Unit: thousand pesos)

Item	Before Project Commencement			After Project Completion		
	2003	2004	2005	2011	2012	2013
Personnel and Maintenance Cost	314,825	305,264	303,986	564,034	493,423	618,029

Source: PAGASA

In addition, Table 5 provides data indicating the yearly budget of HMD, a division

responsible for the operation and maintenance of this project. According to the interviews with PAGASA, the budget is sufficient to operate and maintain the systems and rainfall and water-level gauging stations developed by this project. It should be noted that HMD's budget for the three years after the completion is less than that of the three years before the project commencement because of the difference in personnel cost. According to PAGASA, the personnel cost of the three years before the project commencement includes the personnel cost of each sub center, while the personnel cost at the time of the ex-post evaluation does not include that of sub centers—it only reflects the personnel cost of HMD staff. Although it was attempted during this evaluation study, the personnel cost of sub centers could not be obtained. Nevertheless, sufficient personnel cost is expended according to PAGASA[30]. It can be observed that the other expense items are generally increasing after the project completion. This reflects the fact that PAGASA's responsibilities are expanding as discussed above. According to the interviews with the management of HMD, Pampanga and Agno Sub Centers about the operation and maintenance cost consumed for this project, they confirmed that it was sufficient for the operation and maintenance of the facilities and equipment of the telemetry observation systems, the rainfall and water-level gauging stations and the two sub centers. Considering the above, no major problems are observed in the financial aspects of the operation and maintenance system.

Table 5: Changes in Budget of HMD, PAGASA

(Unit: thousand pesos)

Item	Before Project Completion			After Project Completion		
	2003	2004	2005	2011	2012	2013
Salary expenses	22,807	22,556	19,335	2,248	3,302	3,609
Travel expenses	1,052	1,427	1,370	2,014	2,185	1,981
Telecommunication fees	586	181	196	1,074	577	2,047
Maintenance fees for building and facilities	1,583	413	893	3,383	2,151	2,073
Maintenance fees for vehicles	701	1,232	1,215	2,858	2,114	643
Transportation fees	327	262	252	612	612	612
Equipment expenses	2,594	4,301	3,482	8,741	3,344	4,033
Rent fees	353	928	906	812	812	336
Water, electricity, etc, expenses	3,879	3,783	4,403	6,692	6,589	7,089
Training fees	440	225	215	325	761	414

[30] According to the interviews with the management and other staff of Pampanga and Agno Sub Centers, no concerns were observed in particular concerning the salary levels.

Petrol, oil fees	200	251	340	383	487	634
Insurance	-	-	-	150	150	164
Others	3,259	3,487	4,037	4,059	4,185	8,034
Total	37,781	39,046	36,644	33,351	27,269	31,669

Source: PAGASA

3.5.4 Current Status of Operation and Maintenance

During the field study conducted as part of this evaluation survey, no major problems were observed in the operation and maintenance of the telemetry observation systems procured and installed inside HMD, Pampanga and Agno Sub Centers, the rainfall and water-level gauging stations and the telecommunication steel towers (with the exception of Mayapyap rainfall gauging station, which will be discussed below). Periodic cleaning and checking of the function of the equipment are carried out in accordance with the checklist provided in the maintenance manual. It has been confirmed through the site inspections and interviews with telecom engineers and technicians responsible for the operation and maintenance that equipment was functioning well without any problem. On the other hand, with regard to Mayapyap rainfall gauging station in Pampanga River Basin, the antenna tower within the gauging station was damaged as a result of the typhoon in October 2013.. While PAGASA is drafting a recovery plan at the time of the ex-post evaluation, it is deemed necessary to address the matter as soon as possible[31].

Spare parts are stored in the headquarters of PAGASA (Quezon City). According to the interview with PAGASA, they have not experience any shortage or delayed distribution concerning the procurement of spare parts.

With regard to the theft of sensor signal cables[32] at different rainfall gauging stations, which was described in “3.2.1 Quantitative Effects” under Effectiveness, the Philippine government issued the Republic Act No. 10344 in 2012 (act penalizing unauthorized stealing of equipment and accessories) and is trying to strengthen its control measures. While there is no incidence of theft since 2012, it is expected that PAGASA should continue its efforts for theft prevention.

No major problems have been observed in the institutional, technical and financial aspects of the operation and maintenance system. Therefore sustainability of the project effect is high.

[31] PAGASA does not own the heavy machinery necessary for the recovery work; thus they are requesting DPWH to provide the necessary machinery at the time of the field study (January 2014). According to PAGASA, the recovery work is expected to be completed early this year (and no later than before the rainy season begins in June).

[32] It has not occurred since 2012.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

With an aim to improve the function of FFWS, this project enhanced FFWS related facilities and procured and installed materials and equipment in Pampanga and Agno River Basins located in the Central Luzon Region. At the time of the ex-post evaluation, this project is in line with the policy such as “the Mid-Term Philippine Development Plan” and the development needs to further improve FFWS; thus relevance is high. Through this project, the missing rate of data collection in the telemetry system and the observation time for FFWS improved mostly as planned. In addition, interviews with the local government agencies and towns/villages (barangays) confirmed that FFWS developed by the project was transmitting accurate rainfall and water-level information to the relevant agencies and securing sufficient time for evacuation (lead time) at times of floods. Thus effectiveness and impact is high. Although the project cost was within the plan, the project period exceeded the plan; thus efficiency is fair. On the other hand, problems were not observed in the institutional, technical and financial aspects of PAGASA, the implementing agency; thus sustainability is high.

In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Implementing Agency

1) At Mayapyap rainfall gauging station, the antenna tower was damaged due to the typhoon in October 2013. It is recommended that PAGASA should carry out the recovery work as soon as possible and make efforts toward improving the situation concerning missing rainfall data.

2) With regard to the institutional aspects (particularly the number of staff) of the operation and maintenance, while telecom engineers and technicians at PAGASA’s headquarters have long years of experience and are fully skilled to carry out the required maintenance works, most of the main staff are in their 40s. With a view to ensuring that the facilities and equipment procured and installed by this project continue to be maintained in the future, it is recommended that PAGASA should increase the number of young staff and revitalize the organization thereby establishing the organizational structure in such as way that proper maintenance is ensured.

4.3 Lessons Learned

1) Necessity of Collecting Accurate Information on Project Sites and Scope before the Project

Commencement

In this project a change was made to the project scope in connection to the station building and steel tower construction because it was found at the time of the detailed design that an airport existed near the project site. It is thus critical that both the Japanese and Philippine sides meticulously gather as much information as possible before the project begins thereby striving to determine the project scope in such a way that the project will not be delayed.

2) Accumulation of Training and Human Resource Development for Enhanced Sustainability

PAGASA is conducting training courses in accordance with the needs of its staff. This has been made possible through the long years of Japanese technical assistance which supported human resource development and steadily improved the technical standards of PAGASA. PAGASA began to demonstrate ownership and capacity to organize internal training on its own in the late 1990s. PAGASA also continuously took part in training courses held in and outside the Philippines. Presumably, such efforts also contributed to improving PAGASA's technical standards[33]. Based on such development, it can be said that it is possible to improve the technical skills of the implementing agency and enhance the sustainability of the project if the agency appropriately responds to the training needs[34] and captures training not as a one-time event but as a program that should be worked on continuously.

[33] In addition, it is also because PAGASA understood the increasing needs of the citizens for flood forecasting and warning due to the occurrence of natural disasters.

[34] JICA also contributed to capacitating PAGASA staff by implementing the "Project for Strengthening of FFWS for Dam Operation" in 2009-2012 (technical cooperation project).